

CLAIMS

What is claimed is:

1. A method for processing an image of a biometric comprising:
5 applying a gradient edge detection process to detect features in a
biometric based on data representing an image of at least a portion of the
biometric; and
 modeling the image as a function of the features.
- 10 2. The method according to claim 1 wherein modeling the image includes
constructing the model for at least two resolutions.
3. The method according to claim 2 wherein the resolutions include an outline
15 model at a low resolution and a details model at a high resolution.
4. The method according to claim 3 wherein the biometric is an area of skin
with a friction ridge pattern, the outline model includes edge topology of
ridge features, and the details model includes edge topology and specifics of
ridge deviations and locations and sizes of pores.
- 20 5. The method according to claim 2 wherein the resolutions include an outline
model at a low resolution, a details model at a high resolution, and a fine
details model used to locate and define particular biometric features more
accurately than at the low or high resolutions.
- 25 6. The method according to claim 2 wherein the biometric is an area of skin
with a friction ridge pattern and constructing the model includes identifying,
outlining, and extracting ridge deviation detail and pore features.

7. The method according to claim 6 wherein the ridge deviation detail includes ridge contours including scars; and the pore features include position, shape, and sizes of pores.
- 5 8. The method according to claim 2 wherein the biometric includes at least one of the following: ear shape and structure, facial or hand thermograms, iris or retina structure, handwriting, fingerprints, palm prints, foot prints, toe prints.
9. The method according to claim 1 wherein a gradient is estimated for each
10 pixel of the model after applying a noise filter to the image.
10. The method according to claim 1 wherein the detection process includes using a finite differences process.
- 15 11. The method according to claim 1 wherein the detection process includes:
after calculating the gradients, identifying and marking an image
point as an edge point having a locally maximal gradient in the direction of
the gradient that exceeds a threshold;
identifying neighboring edge points by finding nearest pixels to the
20 original edge point that lie in a direction that is approximately perpendicular
to the gradient direction that passes through the first edge point;
for the nearest pixels, determining gradient values and, for the pixel
with a gradient that is maximal along its gradient direction and has a value
that exceeds a threshold, assigning the pixel to be the next edge point;
25 continuing either until the edge is terminated or the edge closes with
itself to form a continuous curve;
terminating the process at the previously determined edge point if the
gradient of the candidate edge point is less than the threshold; and
repeating the process until all potential edge points have been
30 considered.

12. The method according to claim 1 further including automatically distinguishing biometric features from noise.
- 5 13. The method according to claim 12 further including characterizing the noise as a biometric feature that is below a minimum width or extends less than a minimum distance.
14. The method according to claim 1 further including supporting manual editing of features and selecting features that must be present for a successful match.
- 10 15. The method according to claim 1 wherein modeling includes modeling at least one region of the image of the at least one portion of the biometric.
16. The method according to claim 15 wherein modeling includes overlapping portions of multiple regions.
- 15 17. The method according to claim 15 wherein modeling includes allowing a user to add, extend, or delete features.
- 20 18. The method according to claim 15 wherein modeling includes allowing a user to identify features that must be present for a match.
19. The method according to claim 15 wherein modeling includes allowing the user to adjust the size or position of the model relative to the biometric.
- 25 20. The method according to claim 1 wherein the image is a previously stored image; and modeling includes normalizing a size of the image as a function of a scale associated with the image.
- 30 21. The method according to claim 1 wherein the biometric is an area of skin with a friction ridge pattern and the features include ridge structure with ridge deviation detail.

22. The method according to claim 1 further including displaying the image to a user with an overlay of indications of the biometric features of the image.
- 5 23. The method according to claim 1 further including displaying the image to a user with an overlay of indications of filtered biometric features according to a selectable criteria.
24. The method according to claim 1 further including automatically rotating the
10 image to a specified orientation for displaying to a user.
25. The method according to claim 1 wherein the image is a gray-scale image.
26. The method according to claim 1 further including adding the image of the at
15 least a portion of the biometric to a database.
27. The method according to claim 26 wherein adding the image includes storing the image and the model of the image in the database.
- 20 28. The method according to claim 26 wherein adding the image includes storing the image at full sampled resolution.
29. The method according to claim 26 wherein adding the image includes
compressing the data representing the image prior to storing in the database.
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30. The method according to claim 29 wherein compressing the image includes compressing the image in a lossless manner.
31. The method according to claim 26 wherein adding the image includes
30 compressing the model prior to storing the image in the database.

32. The method according to claim 26 wherein adding the image includes encrypting the data or model prior to storing the image in the database.
33. The method according to claim 26 wherein adding the image includes storing
5 the image and the model of the at least a portion of the biometric with associated information.
34. The method according to claim 33 wherein the associated information includes at least one of: identity of a person associated with the biometric;
10 manufacturer, model, or serial number of the instrument supplying the data representing the portion of the biometric; date of biometric imaging; time of day of biometric imaging; calibration data associated with the instrument used to acquire the image; temperature at the time the image was acquired; unique computer ID receiving the data representing the image from the
15 instrument acquiring the image of the biometric; or name of person logged into the computer at the time the image was acquired.
35. The method according to claim 33 wherein the associated information includes a photograph, voice recording, or signature of the person whose
20 biometric is imaged.
36. The method according to claim 33 wherein the associated information is a watermark.
- 25 37. The method according to claim 36 wherein the watermark is identifying information.
38. The method according to claim 36 wherein the watermark includes anti-tampering information.
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39. The method according to claim 1 further including comparing a previously stored model from a database to a present image.

40. The method according to claim 39 wherein the present image is at least a portion of a biometric of a person having a known identity.
- 5 41. The method according to claim 39 wherein the present image is at least a portion of a biometric of a person having an unknown identity.
42. The method according to claim 39 wherein the present image is received from one of the following sources: live source, local database, scanned
10 image, or other source.
43. The method according to claim 39 wherein comparing includes comparing outline features of the previously stored model to outline features of the present image to determine (i) whether the present image is a candidate for a
15 match or (ii) whether the previously stored model is a candidate for a match.
44. The method according to claim 43 wherein comparing includes determining whether the comparison exceeds a predetermined candidate threshold.
- 20 45. The method according to claim 43 wherein, if the present image is not a candidate for a match, comparing includes comparing outline features of another previously stored model to the outline features of the present image to determine whether the present image is a candidate for a match and if so, using the next previously stored model for details comparison.
- 25 46. The method according to claim 43 wherein, if the previously stored model is not a candidate for a match, comparing includes comparing outline features of a next previously stored model to the outline features of the present image to determine whether the next previously stored model is a candidate for a
30 match and if so, using the next previously stored model for details comparison.

47. The method according to claim 43 wherein, if a candidate match of outline features is found, comparing includes comparing details features of the previously stored model with details features of the present image.
- 5 48. The method according to claim 47 wherein comparing details features includes determining whether the details comparison exceeds a predetermined threshold.
49. The method according to claim 47 wherein comparing details features
10 includes determining whether required features associated with the previously stored model are found in the present image.
50. The method according to claim 47 wherein the biometric is an area of skin with a friction ridge pattern and wherein comparing includes comparing fine
15 details features, wherein comparing fine details features includes determining whether pore features in the previously stored model are found in the present image.
51. The method according to claim 50 further including indicating which pores
20 in the previously stored model appear in expected locations in the present image, including allowing for distortions that normally occur between successive impressions.
52. The method according to claim 51 further indicating a pore count or a
25 statistical probability of an error in at least cases allowing for distortions.
53. The method according to claim 47 wherein comparing details features includes determining whether the details comparison exceeds a predetermined threshold a specified number of consecutive frames.
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54. The method according to claim 53 wherein the details features in successive frames are different.

55. The method according to claim 53 further including selecting another details feature set of the previously stored model for correlating with another details feature set of the present image.
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56. The method according to claim 53 further including: (i) selecting another previously stored model for correlating with a features set of the present image and (ii) declaring a successful match if any model exceeds a predetermined threshold.
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57. The method according to claim 39 wherein comparing includes comparing outline features of the previously stored model to outline features of a model of the present image and, if the comparison exceeds a predetermined threshold, comparing details features of the previously stored model to details features of the model of the present image to determine whether the previously stored model and the present image match.
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58. The method according to claim 39 wherein comparing includes scaling the previously stored model, present image, or model of the present image.
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59. The method according to claim 39 wherein comparing includes rotating the previously stored model, present image, or present model.
60. The method according to claim 39 wherein comparing includes adaptively conforming the previously stored model to account for variability associated with recording or acquiring the present image.
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61. The method according to claim 60 wherein accounting for variability includes accounting for an expected location of predefined features.
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62. The method according to claim 60 wherein the variability includes stretching of the biometric or portions thereof laterally, longitudinally, or radially.

63. The method according to claim 60 wherein the variability is caused by pressure of the biometric on a medium used to record or acquire the present image.
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64. The method according to claim 39 wherein comparing includes comparing the previously stored model against multiple present images until a match is found or comparison with the multiple present images is complete.
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65. The method according to claim 39 wherein comparing includes comparing multiple previously stored models against the present image until a match is found or comparison with the multiple previously stored models is complete.
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66. The method according to claim 39 wherein comparing includes comparing multiple previously stored models against multiple present images until comparing against the multiple previously stored models is complete.
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67. The method according to claim 39 wherein the present image includes multiple biometrics of an individual.
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68. The method according to claim 39 wherein the multiple biometrics are different areas of skin with a friction ridge pattern from the same individual.
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69. The method according to claim 1 further including comparing previously stored models of multiple biometrics to present images of multiple, respective biometrics.
70. The method according to claim 69 further including determining a combined metric based on the comparisons.
71. The method according to claim 1 further including preprocessing the data representing the image.

72. The method according to claim 71 further including subsampling the at least a portion of the biometric to produce the data representing the image.
- 5 73. The method according to claim 71 wherein preprocessing includes decimating the data representing the image.
74. The method according to claim 71 wherein preprocessing includes binning the data representing the image.
- 10 75. The method according to claim 71 wherein preprocessing includes correcting for uneven imaging of the at least a portion of the biometric.
- 15 76. The method according to claim 71 wherein preprocessing includes accounting for defective pixels of an instrument used to acquire the at least a portion of the biometrics.
77. The method according to claim 71 wherein preprocessing includes encrypting the data representing the image.
- 20 78. The method according to claim 71 wherein preprocessing includes changing the image orientation, including changing the image orientation by flipping the image vertically or horizontally or by rotating the image.
- 25 79. The method according to claim 71 wherein preprocessing includes attaching sensor information to the data representing the image.
80. The method according to claim 71 wherein preprocessing includes applying a watermark to the data representing the image.
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81. The method according to claim 80 wherein the watermark includes information used for tamper-proofing the image to allow for identifying a modified image or modified information associated with the image.
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82. An apparatus for processing an image of a biometric, comprising:
a gradient edge detector that detects features in a biometric based on data representing an image of at least a portion of the biometric; and
10 a modeler that models the image as a function of the features.
83. The apparatus according to claim 82 wherein the modeler constructs the model for at least two resolutions.
- 15 84. The apparatus according to claim 83 wherein the resolutions include an outline model at a low resolution and a details model at a high resolution
- 20 85. The apparatus according to claim 84 wherein the biometric is an area of skin, with a friction ridge pattern and the outline model includes edge topology of ridge features, and the details model includes edge topology and specifics of ridge deviations and locations and sizes of pores.
- 25 86. The apparatus according to claim 83 wherein the resolutions include an outline model at a low resolution, a details model at a high resolution, and a fine details model used to locate and define particular biometric features more accurately than at the low or high resolutions.
- 30 87. The apparatus according to claim 83 wherein the biometric is an area of skin with a friction ridge pattern and the modeler includes an identifier, outliner, and extractor to determine ridge deviation detail and pore features.

88. The apparatus according to claim 87 wherein the ridge deviation detail includes ridge contours including scars; and the pore features include position, shape, and sizes of pores.
- 5 89. The apparatus according to claim 83 wherein the biometric includes at least one of the following: ear shape and structure, facial or hand thermograms, iris or retina structure, handwriting, fingerprints, palm prints, or toe prints.
- 10 90. The apparatus according to claim 82 wherein a gradient is estimated for each pixel of the model after applying a noise filter to the image.
91. The apparatus according to claim 82 wherein the detector includes a finite differences processor.
- 15 92. The apparatus according to claim 82 wherein the detector:
after calculating the gradients, identifies and marks an image point as an edge point having a locally maximal gradient in the direction of the gradient that exceeds a threshold value;
identifies neighboring edge points by finding nearest pixels to the
20 original edge point that lie in a direction that is approximately perpendicular to the gradient direction that passes through the first edge point;
for the nearest pixels, determines gradient values and, for the pixel with a gradient that is maximal along its gradient direction and has a value that exceeds a threshold, assigns the pixel to be the next edge point;
25 continues either until the edge is terminated or the edge closes with itself to form a continuous curve;
terminates the process at the previously determined edge point if the gradient of the candidate edge point is less than the threshold; and
repeats the process until all potential edge points have been
30 considered.

93. The apparatus according to claim 82 wherein the detector automatically distinguishes biometric features from noise.
94. The apparatus according to claim 93 wherein the detector characterizes noise
5 as a biometric feature that is below a minimum width or extends less than a minimum distance.
95. The apparatus according to claim 82 further including a manual editing
10 mechanism in communication with the detector to support manual editing of features and selecting of features that must be present for a successful match.
96. The apparatus according to claim 82 wherein the modeler models at least one region of the image of the at least one portion of the biometric.
- 15 97. The apparatus according to claim 96 wherein the modeler models overlapping portions of multiple regions.
98. The apparatus according to claim 96 wherein the modeler allows a user to
20 add, extend, or delete features.
99. The apparatus according to claim 96 wherein the modeler allows a user to identify features that must be present for a match.
100. The apparatus according to claim 96 wherein the modeler allows the user to
25 adjust the size or position of the model relative to the biometric.
101. The apparatus according to claim 82 wherein the image is a previously stored image; and the modeler normalizes a size of the image as a function of a
30 scale associated with the image.

102. The apparatus according to claim 82 wherein the biometric is an area of skin with a friction ridge pattern and the features include ridge structure with ridge deviation detail.
- 5 103 The apparatus according to claim 71 further including a display in communication with the modeler that displays the image to a user with an overlay of indications of the biometric features of the image.
- 10 104. The apparatus according to claim 71 further including a display in communication with the modeler that displays the image to a user with an overlay of indications of filtered biometric features according to a selectable criteria.
- 15 105. The apparatus according to claim 82 further including an image manipulator that automatically rotates the image to a specified orientation for displaying to a user.
- 20 106. The apparatus according to claim 82 wherein the image is a gray-scale image.
107. The apparatus according to claim 82 further including a database that stores the image of the at least a portion of the biometric.
- 25 108. The apparatus according to claim 107 wherein the database stores the image and the model of the image.
109. The apparatus according to claim 107 wherein the database stores the image at full sampled resolution.
- 30 110. The apparatus according to claim 107 further including a compressor that compresses the data representing the image prior to storing in the database.

111. The apparatus according to claim 110 wherein the compressor compresses the image in a lossless manner.
112. The apparatus according to claim 107 wherein the compressor compresses the model prior to storing the image in the database.
113. The apparatus according to claim 107 further including an encryption unit that encrypts the data or model prior to storing the image in the database.
114. The apparatus according to claim 107 wherein the database stores the image and the model of the at least a portion of the biometric with associated information.
115. The apparatus according to claim 114 wherein the associated information includes at least one of: identity of a person associated with the biometric; manufacturer, model, or serial number of the instrument supplying the data representing the portion of the biometric; date of imaging the biometric; time of day of imaging the biometric; calibration data associated with the instrument used to acquire the image; temperature at the time of acquiring the image; photograph, voice recording, or signature of the person whose biometric is imaged; watermark; unique computer ID of the computer receiving the data representing the image from the instrument acquiring the image of the biometric; or name of person logged into the computer at the time of acquiring the image.
116. The apparatus according to claim 114 wherein the associated information includes a photograph, voice recording, or signature of the person whose biometric is imaged.
117. The apparatus according to claim 114 wherein the associated information is a watermark.

118. The apparatus according to claim 117 wherein the watermark is identifying information.
- 5 119. The apparatus according to claim 117 wherein the watermark includes anti-tampering information.
120. The apparatus according to claim 82 further including an input unit that provides a present image, a database that stores previously acquired images and associated models, and a compare unit that compares a previously stored
10 model from a database to a present image.
121. The apparatus according to claim 120 wherein the present image is at least a portion of a biometric of a person having a known identity.
- 15 122. The apparatus according to claim 120 wherein the present image is at least a portion of a biometric of a person having an unknown identity.
123. The apparatus according to claim 120 wherein the present image is received from one of the following sources: live source, local database, image
20 scanner, or other source.
124. The apparatus according to claim 120 wherein the compare unit compares outline features of the previously stored model to outline features of the present image to determine (i) whether the present image is a candidate for a
25 match or (ii) whether the previously stored model is a candidate for a match.
125. The apparatus according to claim 124 wherein the compare unit determines whether the comparison exceeds a predetermined candidate threshold.
- 30 126. The apparatus according to claim 124 wherein, if the present image is not a candidate for a match, the compare unit compares outline features of a next previously stored model to the outline features of the present image to

determine whether the present image is a candidate for a match and if so, uses the next previously stored model for details comparison.

- 5 127. The apparatus according to claim 124 wherein, if the previously stored model is not a candidate for a match, the compare unit compares outline features of a next previously stored model to the outline features of the present image to determine whether the next previously stored model is a candidate for a match and if so, uses the next previously stored model for details comparison.
- 10 128. The apparatus according to claim 124 wherein, if a candidate match of outline features is found, the compare unit compares details features of the previously stored model with details features of the present image.
- 15 129. The apparatus according to claim 128 wherein the compare unit further determines whether the details comparison exceeds a predetermined threshold.
- 20 130. The apparatus according to claim 128 wherein the comparison unit further determines whether required features associated with the previously stored model are found in the present image.
- 25 131. The apparatus according to claim 128 wherein the biometric is an area of skin with a friction ridge pattern and the comparison unit compares details features, wherein the comparison unit determines whether pore features in the previously stored model are found in the present image.
- 30 132. The apparatus according to claim 131 wherein the detector indicates which pores in the previously stored model appear in expected locations in the present image, the detector allowing for distortions that normally occur between successive impressions.

133. The apparatus according to claim 132 wherein the detector further indicates a pore count or a statistical probability of an error in at least cases allowing for distortion.
- 5 134. The apparatus according to claim 128 wherein the comparison unit further determines whether the details comparison exceeds a predetermined threshold a specified number of consecutive frames.
- 10 135. The apparatus according to claim 134 wherein the details features in successive frames are different.
136. The apparatus according to claim 134 wherein the comparison unit selects another details feature set of the previously stored model for correlating with another details feature set of the present image.
- 15 137. The apparatus according to claim 134 wherein the comparison unit (i) selects another previously stored model for correlating with a feature set of the present image and (ii) declares a successful match if any model exceeds a predetermined threshold.
- 20 138. The apparatus according to claim 120 wherein the comparison units compares outline features of the previously stored model to outline features of a model of the present image and, if the comparison exceeds a predetermined threshold, compares details features of the previously stored model to details features of the model of the present image to determine whether the previously stored model and the present image match.
- 25 139. The apparatus according to claim 120 wherein the comparison unit scales the previously stored model, present image, or model of the present image.
- 30 140. The apparatus according to claim 120 wherein the comparison unit rotates the previously stored model, present image, or present model.

141. The apparatus according to claim 120 wherein the comparison unit adaptively conforms the previously stored model to account for variability associated with recording or acquiring the present image.
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142. The apparatus according to claim 141 wherein the comparison unit accounts for variability by accounting for an expected location of predefined features.
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143. The apparatus according to claim 141 wherein the variability includes stretching of the biometric or portions thereof laterally, longitudinally, or radially.
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144. The apparatus according to claim 141 wherein the variability is caused by pressure of the biometric on a medium used to record or acquire the present image.
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145. The apparatus according to claim 120 wherein the comparison unit compares the previously stored model against multiple present images until a match is found or comparison with the multiple present images is complete.
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146. The apparatus according to claim 120 wherein the comparison unit compares multiple previously stored models against the present image until a match is found or comparison with the multiple previously stored models is complete.
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147. The apparatus according to claim 120 wherein the comparison unit compares multiple previously stored models against multiple present images until comparing the multiple previously stored models is complete.
148. The apparatus according to claim 120 wherein the present image includes multiple areas of skin with a friction ridge pattern of an individual.

149. The apparatus according to claim 120 wherein the multiple biometrics are different areas of skin with a friction ridge pattern from the same individual.
- 5 150 The apparatus according to claim 82 further including a comparison unit that compares previously stored models of multiple biometrics to present images of multiple, respective biometrics.
- 10 151. The apparatus according to claim 150 wherein the comparison unit further determines a combined metric based on the comparisons.
- 15 152. The apparatus according to claim 82 further including a preprocessor in communication with the detector that preprocesses the data representing the image.
- 15 153. The apparatus according to claim 152 wherein the preprocessor subsamples the at least a portion of the biometric to produce the data representing the image.
- 20 154. The apparatus according to claim 152 wherein the preprocessor decimates the data representing the image.
155. The apparatus according to claim 152 wherein the preprocessor bins the data representing the image.
- 25 156. The apparatus according to claim 152 wherein the preprocessor corrects for uneven imaging of the at least a portion of the biometric.
- 30 157. The apparatus according to claim 152 wherein the preprocessor accounts for defective pixels of an instrument used to acquire the at least a portion of the biometric.

158. The apparatus according to claim 152 wherein the preprocessor encrypts the data representing the image.
159. The apparatus according to claim 152 wherein the preprocessor changes the
5 image orientation by flipping the image vertically or horizontally or by rotating the image.
160. The apparatus according to claim 152 wherein the preprocessor attaches
10 sensor information to the data representing the image.
161. The apparatus according to claim 152 wherein the preprocessor applies a watermark to the data representing the image.
162. The apparatus according to claim 161 wherein the watermark includes
15 information used for tamper-proofing the image to allow for identifying a modified image or modified information associated with the image.
163. An apparatus for processing an image of a biometric, comprising:
gradient edge detection means for detecting features in a biometric
20 based on data representing an image of at least a portion of the biometric;
and
means for modeling the image as a function of the features.
164. A method for processing an image of a biometric, comprising:
25 acquiring data representing an image of at least a portion of a biometric; and
modeling features of the biometric for at least two resolutions.
165. The method according to claim 164 wherein the resolutions include an
30 outline model at a low resolution, a details model at a high resolution, and a fine details model used to locate and define particular biometric features more accurately than at low or high resolutions.

166. The method according to claim 164 wherein the biometric is an area of skin with a friction ridge pattern, the outline model includes edge topology of ridge features, and the details model includes edge topology and specifics of ridge deviations and locations and sizes of pores.
167. The method according to claim 164 wherein modeling the image includes applying a gradient edge detection process.
168. The method according to claim 164 wherein the biometric includes at least one of the following: ear shape and structure, facial or hand thermograms, iris or retina structure, handwriting, fingerprints, palm prints, foot prints, or toe prints.
169. The method according to claim 164 further including storing the image and model in a database with associated information, including at least one of the following: identity of a person associated with the biometric; manufacturer, model, or serial number of the instrument supplying the data representing the portion of the biometric; date of imaging the biometric; time day of imaging the biometric; calibration data associated with the instrument used to acquire the image; temperature at the time of acquiring the image; photograph, voice recording, or signature of the person whose biometric is imaged; watermark; unique computer ID of the computer receiving the data representing the image of the biometric; or name of person logged into the computer at the time of acquiring the image.
170. The method according to claim 164 further including comparing a previously stored model from a database to a present image.
171. The method according to claim 170 wherein the present image is at least a portion of a biometric of a person having a known identity or having an unknown identity.

172. The method according to claim 170 wherein, if a candidate match of outline features is found, the method further includes comparing details features of the previously stored model with details features of the present image.
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173. The method according to claim 170 wherein the comparing includes adaptively conforming the previously stored model to account for variability associated with recording or acquiring the present image.
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174. The method according to claim 164 further including preprocessing the data, wherein the preprocessing includes at least one of the following:
- subsampling the at least a portion of the biometric to produce the data representing the image;
 - decimating the data representing the image;
 - 15 binning the data representing the image;
 - correcting for uneven imaging of the at least a portion of the biometric;
 - accounting for defective pixels of an instrument used to acquire the at least a portion of the biometric;
 - 20 encrypting the data representing the image;
 - changing the image orientation by flipping the image vertically or horizontally or by rotating the image;
 - attaching sensor information to the data representing the image; or
 - applying a watermark to the data representing the image.
- 25
175. An apparatus for processing an image of a biometric, comprising:
- a data acquisition unit that acquires data representing an image of at least a portion of a biometric; and
 - a modeler that models features of the biometric for at least two
- 30 resolutions.

176. The apparatus according to claim 175 wherein the resolutions include an outline model at a low resolution, a details model at a high resolution, and a fine details model used to locate and define particular biometric features more accurately than at low or high resolutions.
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177. The apparatus according to claim 176 wherein the biometric is an area of skin with a friction ridge pattern, the outline model includes edge topology of ridge features, and the details model includes edge topology and specifics of ridge deviations and locations and sizes of pores.
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178. The apparatus according to claim 175 wherein the modeler includes a gradient edge detector to detect biometric features in the image.
179. The apparatus according to claim 175 wherein the biometric includes at least one of the following: ear shape and structure, facial or hand thermograms, iris or retina structure, handwriting, fingerprints, palm prints, or toe prints.
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180. The apparatus according to claim 175 further including a database that stores the image and model with associated information, including at least one of: identity of a person associated with the biometric; manufacturer, model, or serial number of the instrument supplying the data representing the portion of the biometric, date of imaging the biometric; time of day of imaging the biometric; calibration data associated with the instrument used to acquire the image; temperature at the time of acquiring the image; photograph, voice recording, or signature of the person whose biometric is imaged; watermark; unique computer ID of the computer receiving the data representing the image from the instrument acquiring the image of the biometric; or name of person logged into the computer at the time of acquiring the image.
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181. The apparatus according to claim 175 further including a comparison unit that compares a previously stored model from a database to a present image.
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182. The apparatus according to claim 181 wherein the present image is at least a portion of a biometric of a person having a known identity or having an unknown identity.
- 5 183. The apparatus according to claim 181 wherein, if a candidate match of outline features is found, the comparison unit compares details features of the previously stored model with details features of the present image.
184. The apparatus according to claim 181 wherein the comparison unit
10 adaptively conforms the previously stored model to account for variability associated with recording or acquiring the present image.
185. The method according to claim 175, further including a preprocessor that
15 preprocesses the data, the preprocessor including at least one of the following components:
- a subsampler that subsamples the at least a portion of the biometric to produce the data representing the image;
 - a decimator that decimates the data representing the image;
 - a binning unit that bins the data representing the image;
 - 20 a field flattener that corrects for uneven imaging of the at least a portion of the biometric;
 - a defective pixel correction unit that accounts for defective pixels of an instrument used to acquire the at least a portion of the biometric;
 - an encryption unit that encrypts the data representing the image;
 - 25 an image orientation unit that changes the orientation by flipping the image vertically or horizontally or by rotating the image;
 - a sensor data application unit that attaches sensor information to the data representing the image; or
 - a watermark application unit that applies a watermark to the data
30 representing the image.

186. A method for processing an image of a biometric, comprising:
- 5 means for acquiring data representing an image of at least a portion
of a biometric; and
- means for modeling features of the biometric for at least two
resolutions.